

Linking Arson Incidents on the Basis of Crime Scene Behavior

Pekka Santtila
Police College of Finland and Åbo Akademi University

Katarina Fritzon
University of Surrey

Anna Lena Tamelander
Department of Psychology, Åbo Akademi University

The present study investigated the possibility of statistically linking arson cases based on consistency of behaviors from one crime scene to another. Serial and spree arson cases were studied to differentiate underlying themes and to link cases committed by the same offender. The material consisted of 248 arson cases which formed 42 series of arsons. A content analysis using 45 dichotomous variables was carried out and principal components (PCA) analysis was performed to identify underlying themes. Summary scores reflecting the themes were calculated. Linking effectiveness was tested with a discriminant function analysis using the summary scores. The PCA analysis was successful and underlying themes which were in accordance with previous studies could be identified. Six factors were retained in the PCA. The linking of the arson cases was possible to a satisfactory level: 33% of the cases could be correctly linked and for over 50% of the cases, the series they actually belonged to was among the ten series identified as most probable on the basis of the linking analysis. From a practical point of view, the results could be used as a basis for developing support systems for police investigations of arson.

LINKING A series of offenses to a single offender is arguably one of the most important tasks of a police enquiry team. It can lead to increased resources for an enquiry team and can ultimately improve clear-up rates if one offender is convicted for several offenses. This is particularly important in the case of arson which, almost universally, has a very low clear-up rate. For example, in the UK in 1997 of 76,500 fires recorded as malicious by the

fire brigade, only 31,500 (41%) were recorded as crimes by the police, and only 1,500 individuals were convicted (Home Office, 1999). Linking a number of offenses to the same individual also provides an enquiry team with more information on the offender and can be used to narrow the search area for potential suspects using geographical profiling (e.g., Canter & Larkin, 1993; Canter & Gregory, 1994; Santtila, Häkkinen, & Fritzon, 2003).

Serial Offending

Serial offending raises important psychological questions as well as practical investigative ones. Some suggestions as to why offending behavior is repeated can be derived from theories of crime, although these apply primarily to crimes with a clearly instrumental purpose (e.g., Cornish & Clarke, 1986). In terms of arson, however, the reasons for repetition are perhaps less obvious. Of all the explanations offered in the literature on arson, the one which makes explicit the mechanism by which fire setting might become habitual is the functional analytic perspective (Jackson, Hope & Glass, 1987; Jackson, 1994) which is used in the UK as a basis for clinical intervention with arsonists. In summary, this model proposes that for individuals who possess a poor repertoire of social skills, arson may become a means of achieving goals and influencing the environment. Assuming that the arsonist does not learn other equally effective means of achieving these goals, or becomes discouraged from setting fires, the behavior may be expected to continue. In a shorter time perspective, the offender may find an incident of fire setting rewarding and may immediately move on to commit another. Under such circumstances, the intervening events of learning or being discouraged are unlikely to be operative.

The present paper examines arson incidents which were identified as forming part of a series or constituting a spree of arsons. A spree of arsons is defined as two or more fire settings by the same offender during a 24-hour period (Canter & Fritzon, 1998). If the time lapsed between the arsons is more than 24 hours, then they are defined as a series. Previous research (Canter & Fritzon, 1998; Fritzon, Canter & Wilton, 2001; Häkkinen, Puolakka, & Santtila, in press)

has examined behavioral variation in arson and identified four main subgroups. For example, Canter and Fritzon (1998) developed a model which classified cases according to the target and the motivational source. The targets were either people or objects, and the motivation originated either within the arsonist (expressive) or from outside circumstances (instrumental). These aspects formed four categories: Instrumental Object, Instrumental Person, Expressive Object and Expressive Person. Arsons that were part of a spree or a series were mostly of the Expressive Object type. It would, therefore, be expected that differentiation within the phenomenon of repetitive arson would most likely consist of different emphases on arsons targeted at objects. In an earlier study of 83 serial arsonists, Sapp, Huff, Gary, Icove, and Horbert (1994) found that the most common cited motive for serial fire setting was revenge. The precise nature of this revenge, however - which was stated to be retaliation against society - makes it more similar to the Expressive Object form of arson identified by Canter and Fritzon (1998), rather than the more conventional notion of revenge against a person.

Consistency in Offense Behavior

The issue of consistency and change in criminal behavior over time has been the subject of extensive debate within the criminological literature (e.g., Farrington, 1989; Pulkkinen, 1983). This research has tended to take a broader 'criminal career' focus than the present study, which aims to examine whether specific actions performed in relation to a particular instance of an offense form a recognizable pattern when compared with other occasions that the offense is committed.

The notion of consistency in the nature of criminal behavior has been formalized in Canter's (1995) Consistency Hypothesis. This argues that "the way an offender carries out a crime on one occasion will have some characteristic similarities to the way he carries out crimes on other occasions" (p. 5). He extends this notion beyond the concept of *modus operandi* by focusing on a more 'thematic' interpretation of crime scene behavior. According to this hypothesis, therefore, not only may arsonists demonstrate a preference for property related crime, they may also reveal a tendency to commit a particular style of arson. Central to this question, however, is the role of the situation in influencing a particular behavior. If the variations caused by different situations are greater than the variations between people, then it is unlikely that clear consistency within individuals will be found. The person/situation interaction in offender behavior has been emphasized by Alison, Bennell, Mokros and Ormerod (2002). They state that "most varieties of offence behaviour for which profiling may be of relevance are generally characterized by the diametrically opposed interests of the offender and victim", and "therefore the influence of situational factors and the role of the victim should not be neglected" (p.123). In arson, the victim is not always present at the crime scene, and thus may be expected to have minimal effect on the arsonist's behaviour, increasing the chances of finding consistency. However, the offender may be affected by characteristics of the crime scene.

Thematic consistency

Consistency in offense behavior is more likely to be expressed through the common themes underlying different

combinations of actions rather than through single salient actions. Identifying the combinations of variables which can account for an offender's individuality would, therefore, be an important step in facilitating an understanding of consistency and development in offending behavior over time.

The frameworks adopted in previous thematic analyses of arson (Canter & Fritzon, 1998; Fritzon et al., 2001, Håkkanen et al., in press) do not explicitly provide hypotheses for examining whether a person who sets a fire according to a particular thematic style on one occasion is likely to continue to set fires in a similar style on future occasions. However, the issue of consistency and change has been widely debated within the literature on personality, particularly in relation to trait theories of personality. The central notion of a trait is that it is a "disposition to behave in a particular way which is evident by one's behaviour over many situations" (Pervin, 1989, p. 287). Alison et al. (2002) criticize the traditional trait theory especially within the area of profiling. They point out that many profilers depend on a naive trait perspective, which does not take into account the context in which a person is active. Further, profilers often claim, without any scientific evidence, to know facts such as age, ethnicity and marital status, which are not even appropriate characteristics for the psychological definition of traits. Alison et al. (2002) also state that many profilers openly admit that much of what they do is based on intuition and experience and are thus subjective opinions and beliefs. McClelland (1980) argues that to predict behavior successfully, measures of motives, schemas and traits must all be considered together. This is particularly relevant to the current paper, as the three

factors are embedded within the thematic classification systems for arson previously mentioned (Canter & Fritzon, 1998). By taking the simple definition of a motive as the source of behavior, the action systems framework, adopted by Fritzon et al. (2001), explicitly states that this is either internal or external to the person. In terms of schemas and traits, these might implicitly be expected to influence the tendency of a person's behavior to be focused internally or externally. If the prediction of behavior must account for motives, schemas and traits, therefore, then these classification systems potentially provide the most useful framework for an examination of consistency over time. In these terms, then, it is proposed that the mode of functioning which an individual arsonist expresses during one act of fire setting might be expected to also be communicated in further offenses. Indeed a recent study (Miller & Fritzon, submitted) using the action systems framework found some evidence for consistency of functional mode across two behavioral modalities; fire setting and self-harm.

The study by Sapp et al. (1994) reported above identified that certain forms of arson behavior are more likely to be engaged in by serial offenders. However, this does not tell us about the relationships among the variables, and whether coherent themes of behavior can be identified for this sub-group of arsonists, as has been identified in previous studies of general arson samples. It is by examining these associations that meaning is derived and the processes underlying serial arson may be revealed. The identification of thematic patterns of behavior is central to the issue of consistency. One of the aims of this paper is to give further insight into why certain forms of arson are repeated, i.e., what reinforcing functions are served by the behavior. This

will be achieved by analyzing the co-occurrence of behaviors associated with serial and spree arsonists and discussing the underlying psychological meaning that is revealed by patterns of co-occurrences.

In summary, the present study had two aims. First, an attempt was made to identify different offending styles in repetitive fire setting. Second, based on the identified offending styles, linking of offenses committed by the same offender was attempted. Additionally, the question of whether the time between the offenses would have an effect on the consistency of behavior was addressed by comparing linking effectiveness between spree and serial arson.

METHOD

Cases

The data consisted of 248 separate fire setting incidents committed by 42 different arsonists (38 male, 4 female arsonists) during a 10-year period from 1991 to 2001 in different parts of Finland. There were 6 series with two arsons, 5 series with three arsons, 9 series with four arsons, 4 series with five arsons, 14 series with 6-10 arsons, and 4 series with over 10 arsons. A list of the cases was obtained by searching the electronic database of crime reports of the Finnish police. As offenses related to fire setting are coded under a number of different crime categories, it is not possible to obtain an exhaustive list of such offenses by means of a simple search. Therefore, the database was searched using a free-text search with a list of search words relating to fire setting and the offense categories under which these incidents may be coded. Consequently, the number of missed arson cases is not known. However, for practical purposes the sample can be considered fairly exhaus-

tive of repetitive arsons taking place during the time period noted above.

Content analysis of the case files

The case files typically contained a record of the suspect's interrogation, possible witness statements, medical examiners statement, and records of possible forensic evidence. These files were subjected to a content analysis (see Holsti, 1969; Krippendorff, 1980) using a list of variables related to both the crime scene actions observed in the offenses, the characteristics of the offenders as well as their post-offense behavior (including behavior during police interrogation). The variable list was created based on previous research (Canter & Fritzon, 1998; Fritzon et al, 2001; Häkkänen, Puolakka, & Santtila, in press) and through reading a sample of the case files. All variables were dichotomous and a decision was only made as to the presence of the variable in question (coded as 1), otherwise the variable was coded as 0.

The original list of variables related to crime scene behavior of the offenders was subjected to a preliminary screening to obtain a list of reliable and robust variables for subsequent analyses. Several variables were excluded due to low frequencies. The remaining variables that were used in the analyses and their definitions can be seen in Table 1.

For a number of variables the assumption that when the occurrence of a behavior is not mentioned, it is assumed that the behavior did not occur at all may be relatively accurate. However, that is not necessarily the case at all times, and so for other variables this procedure may underestimate the true occurrence rate of the behavior in question which should be kept in mind when the results are interpreted.

Inter-rater reliability

To estimate the inter-rater reliability of the content analysis, Cohen's κ values (Brennan & Hays, 1992; Cohen, 1960) were calculated for a random sample of 10 cases. These 10 cases were independently coded by two raters using the variable list. Variables for which a Cohen's κ value could not be calculated (i.e., same value throughout the material, no observations by either of the coders) were removed. Separate Cohen's κ values were computed case wise (i.e., for the pair of codings for each of the 10 arsons at a time instead of for the variables in these cases). The mean Cohen's κ value was .79 (SD = .06) with a minimum of .70 and a maximum of .89 for the 10 computations. In percentages the mean agreement was 92.8% (SD = 2.7%) with a minimum of 87.6% and a maximum of 97.1%.

Statistical analyses

In order to discover which of the crime scene behavior variables form coherent subsets that are relatively independent of each other, a principal components analysis (PCA) was conducted. As stated above, the crime scene behavior variables included in the PCA were all dichotomous. Contrary to some descriptions of the method, dichotomous variables can be analyzed using PCA. For example, in one of the classical texts on factor analysis, Harman (1976, p. 24) describes the question as follows:

An especially pertinent question arises when dealing with dichotomous data. Strictly speaking, factor analysis requires that the correlations be of the product-moment type even in this case. Of course, the correlation from a fourfold table for two dichotomous variables is a product-moment correlation between the two variables, each

of which has two point values. Such a measure is sometimes called 'coefficient of association' or 'fourfold point correlation' or 'phi coefficient'. By any of these names it is still a product-moment correlation.

Also, Tabachnik and Fidell (2001) point out that as long as PCA is used descriptively to summarize relationships in a large set of observed variables, assumptions regarding the distribution of variables are not in force. If normality fails or if the relationships among pairs of variables are not linear, the solution may be degraded, however. In addition, for PCA, multicollinearity is not a problem, as there is no need to invert the correlation matrix.

To assess the linking effectiveness of the factors identified through the PCA, a discriminant function analysis was conducted. Summary scores formed on the basis of the PCA were used as independent variables, with the series into which a particular arson case belonged as the grouping variable.

Discriminant analysis can be used to build a predictive model of group membership based on observed characteristics. In the present case the predictions were which series an arson incident belonged to, and the observed characteristics were the summary scores formed on the basis of the PCA. The procedure generates a set of discriminant functions based on linear combinations of the predictor variables that provide the best discrimination between the groups. The functions are generated from a sample of cases for which group membership is known; the functions can then be applied to new cases with measurements for the predictor variables but unknown group membership.

In the present analysis, all independents were entered simultaneously. Classification of cases was requested using the "leave-one-out" classification. In this method, each case in the analysis is classified by functions derived on the basis of all cases other than that case. Therefore, it provides an unbiased estimate of the classification effectiveness of the discriminant function, suggesting how well the function would work with new cases not belonging to the sample in question. Prior probabilities for series membership were obtained from the number of cases in a particular series.

Also, discriminant scores were computed for each case. These scores are computed by multiplying the unstandardized discriminant coefficients by the values of the independent variables, summing these products, and adding the constant. One score was produced for each discriminant function derived. These scores were computed in order to further assess the ability of each of the theme variables to capture consistencies within series. A simple procedure was adopted for this assessment: standard deviations (SDs) were computed for each of the discriminant scores for each series to get an assessment of the variability of the scores within series.

The SDs were then compared to the SD for all the cases. The proportion of series SDs that were below the SD for all the cases was then compared to the proportion of series SDs above the SD for all the cases using a binomial test.

Clearly, consistency of behavior within series would be indicated by a disproportionate number of series SDs being below the SD for all the cases.

RESULTS

Principal components analysis of the crime scene behaviors

To begin, a PCA of the 45 crime scene behaviors was conducted (see Table 1 for definitions and frequencies). The first step in the analysis was to inspect the correlation matrix for factorability. It included several correlations in excess of .30 with significance tests of the correlations showing a sizable portion of the correlations to be significant. In addition, the anti-image correlation matrix contained mostly small values. Also, Bartlett's test of sphericity had a significant value ($\chi^2(990) = 3299.24$, $p < .001$), suggesting further that the correlations in the matrix were not zero. However, as it is highly dependent on N it would be likely to produce a significant value in the present case even if the correlations were low. Therefore, also the KMO Measure of Sampling Adequacy was inspected. It gave a value of .60, which suggests that the matrix is factorable (Tabachnick & Fidell, 2001).

Next, a principal components extraction with varimax rotation was performed on the 45 crime scene behaviors for the sample of 248 arson cases. The inspection of the scree plot, as well as a preliminary run to determine components with an adequate number of behaviors loading highly on them, led to the retention of six components. See Table 2 for initial Eigenvalues and percentages of variance explained by the solution.

When oblique rotation was requested, the components tended to have negligible correlations with each other, so the orthogonal rotation was retained. Table 3 shows the rotated component matrix. With a cut of .32 for inclusion of a variable in interpretation of a factor, 10 of the 45 variables did not load on any fac-

tor, suggesting that the solution is reasonably adequate and that the crime scene action variables were not excessively heterogeneous. However, seven of the variables were complex, i.e., loading on more than one factor.

Factor 1: Expressive Person. This factor was similar to the theme identified by Canter and Fritzon (1998) and Häkkanen, Puolakka, and Santtila (in press) with the same name. The positive loadings of *residential*, *lives endangered*, *personal property taken* and *self* suggest a pseudo-suicidal act where the arsonists themselves are the targets, with the fire taking place in their own home with no attempt to alert others. Additionally, the negative loadings of *miscellaneous/uninhabited property*, *outside* and *trash* which were all variables from the "Instrumental Object" theme in Canter and Fritzon (1998) indicate that these two forms of arson behavior are at polar ends of a psychological continuum of modes of functioning associated with setting fires. Indeed, this is the argument proposed by Shye (1985) in his paper on behavioral action systems, which was developed in relation to arson by Fritzon, Canter and Wilton (2001).

Factors 4 and 6: Instrumental Person/Destroy. Interestingly, the other person oriented form of arson, which has been identified in previous studies, is represented by two factors, 4 and 6, each with a slightly different emphasis. Factor 4 is characterized by the variables *night*, *victim known person*, *again [returns to same scene]* and *other crime committed*. Together, these variables indicate a more acquisitive form of instrumentality than is usually found in Instrumental Person fires. The known victim may in this case represent either property or person targets, given that the arsonist is returning to set a second fire at the same location.

In the case of Factor 6, the variables *remained at scene*, *did not alert others*, *rural*, *prior threat of violence* in combination with a negative loading on *opportunistic*, are reflective of a targeted and planned form of arson which may be interpreted as a form of revenge. However, the absence of positive loadings on any of the victim relationships, *victim partner friend*, *victim family relative*, or *victim known*, suggests that in this case the revenge may be undifferentiated and perhaps arising out of a general feeling of dissatisfaction or distress with the arsonist's personal circumstances. For this reason it would not be appropriate to label this factor "Instrumental Person" as the person target is not identified. Instead, this Factor is named "Destroy" after Fritzon, Canter and Wilton (2001) which evokes a sense of the individual wishing to have an impact by targeting an aspect of their environment.

The other three factors appear to be variations on the two object oriented forms of fire setting identified in previous research.

Factors 2 and 5: Expressive Object. The absence of any overt instrumentality involved in either of these forms of arsons suggests that they are both more likely to be driven by internal motives. The variables loading positively on Factor 2 are: *arsonist moves by foot*, *trash receptacles*, *alcohol consumed*, *matches used for lighting* and *material brought to scene*. The latter two variables are indicative of an arson that is at least partially planned, and the type of target suggests that the offender is not necessarily attracted by any external qualities of the target. The negative loadings on *arsonist moves by vehicle*, *vehicle target*, and *more than one offender* reinforces the lack of sophistication of the perpetrator of this type of offense, and also confirms

the lack of any externally located motive, such as peer involvement or car crime.

Factor 5 suggests a more determined or well-rehearsed form of arson in which targets with particular properties are sought. The desire to create a large fire with external impact is indicated by *public view*, *multiple items* and the *business premises* and *public institution* targets and this is reinforced by *set fire* (as opposed to missile) which shows the arsonist making an effort to ensure that the fire takes hold.

Both types of arson represent psychologically the same underlying process by which the desire to set fires manifests itself in the selection of a variety of possible targets. It may also be speculated that, in the same way as rehearsal through fantasy has been found to preface some forms of serial sexual killing (MacCulloch, Snowden, Wood & Mills, 1983), serial arsonists may progress from less sophisticated fire setting to more destructive and impacting behavior in terms of target selection and size of fire.

Factor 3: Adaptive. The adaptive label for this factor is taken after Fritzon, Canter and Wilton (2001), who describe this form of arson as opportunistic manipulation of the environment. The co-occurrence of *matches used for lighting* with *opportunistic* reflects this, although the variable *material brought to scene* may indicate tools to carry out the forced entry. The fact that the predominant target here is a *storage facility* suggests a possible acquisitive motive, although the destruction of property may be more important than the possibility of any direct gain.

Assessing linking effectiveness

In order to assess the linking effectiveness of the factors based on the PCA on one hand and the themes from MDS analysis on the other hand, two

discriminant function analyses using summary scores based on these analyses and the series into which a particular arson case belonged as the grouping variable were conducted. The Eigenvalues for the three first discriminant functions were higher than 1, the proportions of variance explained by each function varied from .32 (function 1) to .05 (function 6). All of the different functions were statistically significant (all $ps < .001$).

Finally, Table 5 presents the structure matrix of the discriminant functions indicating the contribution of each of the summary scores to the different functions.

Next, the series SDs of the discriminant scores on each of the functions were compared to the overall SD for that function. Table 6 shows the results from binomial tests of whether the series SDs tended to be more often below the overall SDs than expected by chance (.50).

Next, the classification effectiveness of the discriminant functions was tested. The correct classification rate using leave-one-out classification using discriminant functions based on the principal components was 32.7% (with all cases used in the construction of the functions, the correct classification rate was 44.0%). The correct classification rate expected by chance was 3%.

Discriminant analysis, in addition to indicating the group to which a case is most likely to belong on the basis of the observed characteristics, in this case, crime scene behavior, also produces probabilities of the case belonging to the other groups in the analysis. Based on these probabilities, the proportion of cases for which the actual series was among a specific number of series to which the cases had the highest likelihood of belonging, was computed. For the present material, for 129 out of the

248 cases (52.0%) the right series was among the ten most probable series. Figure 1 shows the distribution of cases having the right series among a specified number of most probable series.

The difference between classifications of series of arsons and spree arsons was also tested. It would have been expected that spree arsons committed by a single offender that occur within 24 hours would be more alike than serial arsons committed by a single offender, as these can occur months or years from each other and that consequently the spree arsons would be easier to link to each other. But there were no significant differences between these two $\chi^2(1) = 0.84, n.s.$ (of the serial arsons 41.8% and of the spree arsons 47.8% were correctly classified as belonging to the right series [these percentages were not based on the leave-one-out classification and, therefore, differ from the figures presented above]). This shows that the time lapsed between two arsons has no significance as to how different or alike the crime scene behaviors on these two occasions are.

DISCUSSION

The present paper examined the nature of serial and spree arson both in terms of its structure in relation to the models of fire setting presented in previous research and in relation to consistency and change across a series. A discriminant function analysis based on a principal components analysis (PCA) found that serial and spree arsonists commit their fire setting in a similar manner on different occasions to a both practically and statistically significant degree. This has important implications for arson investigations, as it presents the possibility of apprehending an arsonist early in a series using linking based on crime scene

behavior. Linking was possible using of the PCA.
summary variables formed on the basis

Table 1. Crime scene behaviors

Name	Definition	% of Offenses
Matches	Matches used for lighting	66.9
Matbrought	Lighting material brought to crime scene	63.3
Setfire	Set fire	59.3
Misc	Miscellaneous, derelict, warehouse, abandoned	52.4
Alcohol	Alcohol use	50.8
Movefoot	Moves by foot	45.2
Night	Night=00:00-05:59, day=06:00-23:59	38.3
Objout	Outside	37.9
Lives	Lives endangered deliberately/by location, people injured	30.2
Mile	Distance travelled less than a mile (appr.1,6 km)	27.0
Residential	Private house, residential building	25.4
Trash	Trash bin, trash shed	22.2
Planned	Planned, targeted, non-opportunistic	21.0
Movebic	Moves by bicycle	18.1
Opportunistic	Climbing, through open door	15.7
Highdamage	Damage more than 1500€	14.5
Movevehic	Moves by car/motorcycle	12.5
Business	Business premises (e.g. shop, kiosk, gas station)	12.5
Moreoff	More than one offender	12.1
Apartment	Apartment	11.3
Personalproperty	Personal property from the premises	10.9
Storage	Storage	10.9
Publicview	Public view	10.5
Multistory	Multi-story house, public area (e.g., stairs, elevator)	9.7
Remained	Remained at/returned to scene	9.7
Otherlevel	Multi-story house, other level (i.e., not ground floor)	9.3
Forced	Forced/illegal entry	8.9
Vehicle	Car/vehicle burned	8.5
Notalert	Did not alert anyone	8.5
Drugs	Drug use, also prescription drugs	7.7
Rural	Forrest, hey barn	7.7
Multitems	Multiple items fired	7.7
Again	In serial/spree arson returns to same scene	7.3
Known	Victim other known person	6.9
Gasoline	Gasoline used	5.2
Familyrelative	Victim part of immediate family, relative	4.8
Othercrime	Other crime, place rummaged, things stolen	4.8
Multseat	Multiple seats of fire	4.8
Public	Public institution, school	4.8
Partnerfirend	Victim partner or friend	4.4
Flamfluid	Flammable fluids, gas, accelerants	4.4
Self	Self (own apartment/home)	4.0
Unsuccessful	Unsuccessful lighting places	2.4
Threatarson	Prior threat of arson	2.4
Threatviolence	Prior violence or threats	1.6

Table 2. Principal Components Analysis (PCA) of 45 crime scene variables (N = 248)

Factor	Initial Solution			Rotated		
	Eigenvalues	% of Variance	Cum %	S.Sq.Loadings	% of Variance	Cum %
1	4.64	10.31	10.31	4.22	9.37	9.37
2	2.87	6.37	16.69	2.73	6.06	15.43
3	2.48	5.52	22.20	2.35	5.22	20.65
4	2.14	4.76	26.96	2.34	5.20	25.85
5	2.06	4.57	31.53	2.33	5.18	31.03
6	1.97	4.38	35.91	2.20	4.88	35.91

According to a previous study by Canter and Fritzon (1998), fire setting incidents can be classified into four sub-groups, depending on the target and motivational aspects of the incident. These four categories - Instrumental Object, Instrumental Person, Expressive Object and Expressive Person - were as a whole supported by the present study. However, findings from the present study suggested that some classifications may require further clarification. Canter and Fritzon (1998) identified serial arsons as being mostly crimes where the target was an object. Thus, in the present study, it was expected that in dividing serial and spree arson incidents into sub-groups, the emphasis would be on arsons where the locus of effect was an object. This was, however, not fully the case. As expected, object arson incidents were present, but also all other sub-groups described by Canter and Fritzon (1998) could be found within the serial and spree arsons.

The existence of the Expressive Person type of arson was supported by factor 1 in the PCA. In accordance with previous studies (Canter & Fritzon, 1998) these incidents were shown to be forms of pseudo-suicidal acts, where the arson was directed at the self.

The variables from the Instrumental Person region were found in factors 4 and 6. The Instrumental Person form of arson has previously been connected with revenge against a person (Canter &

Fritzon 1998). The division of these variables in the PCA broadens the view of the instrumental arsons. The variables indicate an instrumental form of arson, but in combination with a known *object* target, there is a possibility of a form of revenge against society. This is similar to the finding by Sapp et al. (1994) that the most common motive for serial arson was a form of retaliation against society. This aspect of revenge did not form a separate classification in the Canter and Fritzon (1998) study, which may be due either to a failure to recognize a broader target for revenge in their sample, or because revenge against society is mostly evident in serial arsons, which was the focus of both the present study and the Sapp et al (1994) study.

When looking at the Expressive Object form of arson Factors 2 and 5 indicate the possibility of two forms of Expressive Object arsons. The variables found in Factor 2 may be the core variables for this group of offenses. The fact that these can be interpreted as indicating an undifferentiated target, and therefore possibly an internally driven motive, is reflective of the self-fulfilling nature of serial arson. The Expressive Object region is where Canter and Fritzon (1998) found the serial behavior. Thus the present study did as expected give further divisions to this region as several forms of Expressive Object crimes were identified.

Table 3. Rotated component matrix from the Principal Components Analysis (PCA) of the 45 crime scene behaviors (N = 248)

Crime scene behavior	Factor					
	1	2	3	4	5	6
residential	.78					
lives	.74					
Misc	-.68					
objout	-.67					
otherlevel	.57					
apartment	.52				-.37	
multistorey	.47					
Mile	.46					.44
personalproperty	.40					
Self	.36					
trash	-.52	.40				
movefoot		.65				
alcohol		.52				
movevehic		-.51				
moreoff		-.35				
vehicle		-.52	-.40			
matches		.46	.37			
matbrought		.42	.49			
forced			.55			
opportunistic			.48			-.43
storage			.47			
movebic			.45			
highdamage						
multseat						
night				.58		
known				.54		
again				.52		
othercrime				.51		
drugs						
publicview					.67	
business					.60	
multitems					.39	
public					.39	
setfire					.38	
flamfluid						
remained						.53
notalert						.50
rural						.39
theratviolence						.34
familyrelative						
threatarson						
unsuccessful						

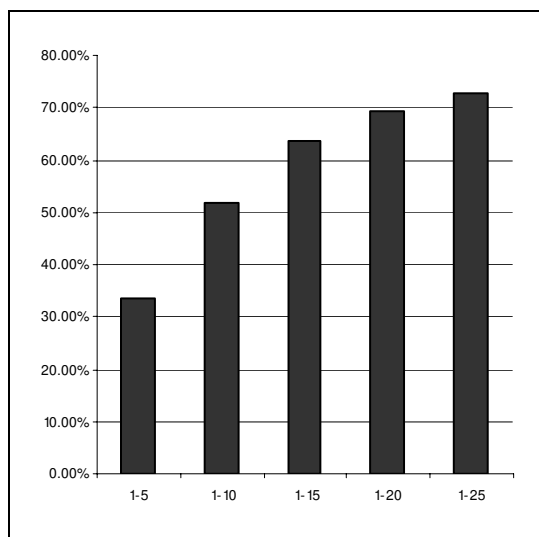
Note. Rotation converged in 9 iterations.

Table 4. Structure matrix of the discriminant functions based on a Principal Components Analysis (PCA)

	Function					
	1	2	3	4	5	6
Factor 6	.56	.41	.25	-.01	-.29	.59
Factor 1	.56	.11	.17	-.43	.43	-.50
Factor 4	.26	.19	-.74	.48	.33	-.00
Factor 3	-.11	.01	.45	.67	.20	-.53
Factor 2	.34	-.53	.19	.71	-.17	-.15
Factor 5	-.17	-.30	.20	.29	.59	.62

Table 5. Assessment of within-series behavioral consistency as captured by the discriminant functions using binomial tests. Based on a Principal Components Analysis (PCA)

Function	% of series with SD < overall SD	P(two-tailed)
1	.91	.001
2	.86	.001
3	.89	.001
4	.80	.001
5	.77	.001
6	.64	.097

Figure 1. The distribution of arson cases having the right series among a specified number of most probable series

Factor 5 is broadly the Expressive Object type of arson. The factor contained the variables *business* and *public building* as well as *public view* and *set fire*. These suggest that the arsonist chooses targets with particular qualities, e.g. the likelihood of creating a large fire. Additionally, it is possible to exclude an instrumental motive in targeting these properties due to the variable *opportunistic* indicating that the arsonist has not set out with a specific plan.

The final factor (3) was rather undifferentiated in the PCA and not totally in accordance with an Instrumental Object interpretation as identified in previous studies. This could be due to Factor 3 containing two of the highest frequency variables, *matches* and *material brought to scene*, which were the core behaviors that were not necessarily more associated with one behavioral style over another. In considering these divergences between the findings in the present study and those from previous research, the variable to case ratio in the present study must be borne in mind. Although acceptable at 5 to 1, it is nevertheless on the low side, which suggests some caveats concerning the stability of the identified factors.

Being able to link serial crime can be of great help to investigators. If a series of crimes can be linked to one offender, then by means of checking alibis and

whereabouts of suspects during a number of the arsons in a linked series several suspects can possibly be ruled out and the list of suspects is clearly shortened. Also in non-linked crime series, it can be hard to prove that a suspect has been at all crime scenes, and thus often the suspect can only be convicted of one crime. It can prove helpful to the investigations to be able to link cases and try to prove that a suspect has had the possibility to be at all crime scenes, instead of trying to find suspects separately for each case.

In the present study serial or spree arsons could be linked to a satisfactory level. Very seldom do offenders have one "fingerprint" behavior that can be directly identified and that can tell them apart from other offenders (Canter & Heritage, 1990). However, clusters of behaviors can be descriptive, and if such clusters can be identified then they can work as the "fingerprint" that can help us link crimes to one offender. Optimally, the investigators would identify patterns of behavior that exist in all of the crimes within a series but in none of the other series. This is, of course, not the case. It cannot be expected that a single crime can be linked to only the right series of crimes, as arsons by several different offenders can be very much alike. Thus, when linking crimes, the investigators hope to reduce the number of possible series to which one single crime could belong, instead of hoping to find only one perfect match.

In the present study the leave-one-out method of classification was used when trying to link cases to one offender. When the case being classified was a part of the functions derived, the percentage of accurate classifications was significantly higher, but the generalizability of these findings is not clear. The leave-one-out method gives us a more realistic picture of the classification effectiveness

because when trying to link a new case to previous cases in crime investigations, the new case cannot be a part of the derivation of functions in the linking process. With the leave-one-out method in the present study for over 50% of the cases the right series was among the ten most probable series, and for over 30% of the cases the right series was the most probable. This shows that linking is possible and can be also practically useful.

It was also shown that the time lapsed between two arsons by the same offender had no significance as to how different or alike the two crimes were, since no difference in the success rates for linking spree arsons and serial arsons was found. The current study therefore has developed further the notion of consistency in criminal behavior, which has previously been confined to consistency in offense *type* across time (e.g. Farrington, 1989), by showing consistency in offense *style*.

The implications of the research extend to the practical investigations of crime and provide evidence for the utility of developing *pro formas* for crime scene investigations where the same behaviors would be recorded, thus improving the efficiency of the linking process. In a recent study concerning the linking of commercial burglary, Bennell and Canter (2002) stated that it is important to know which variables are the least context specific and thus are most useful for the linking process. They continue by saying that "...collecting appropriate, possibly limited, information carefully may be more effective than collecting a great deal of information in hope that some of it may turn out to be of value" (p.11).

To conclude, the present study has shown that the structure of serial and spree arsons follows similar patterns to those of single arson cases in previous studies. Also linking a series of crimes to one offender has been successful. The

results from the present study can be helpful to crime investigations in providing a basis for linking a number of crimes to one offender, and thereby reducing the list of potential suspects. A more efficient method of investigation might be made possible by focusing on carefully selected variables to record information from the crime scene. Future studies might investigate the utility of additional variables for linking, for example, the predictive value of the distances between crime scenes has been shown to be effective in linking burglaries (Bennell & Canter, 2002)

REFERENCES

- Alison, L., Bennell, C., Mokros, A., & Ormeord, D. (2002). The Personality Paradox in Offender Profiling, a theoretical review of the processes involved in deriving background characteristics from crime scene actions. *Psychology, Public Policy, and Law*, 8, 115-135.
- Bennell, C. & Canter, D. V. (2002). Linking commercial burglary by modus operandi; tests using regression and ROC analysis. *Science and Justice*, 42, 1-12.
- Brennan, P. F., & Hays, B. J. (1992). The Kappa statistics for establishing interrater reliability in the secondary analysis of qualitative clinical data. *Research in Nursing and Health*, 15, 153-158.
- Canter, D. (1995). Psychology of offender profiling. In R. Bull and D. Carson (eds.) *Handbook of psychology in legal contexts*. Chichester, England: John Wiley & Sons.
- Canter, D. & Fritzon, K. (1998). Differentiating arsonists: A model of fire setting actions and characteristics. *Legal and Criminological Psychology*, 3, 73-96.
- Canter, D. & Gregory, A. (1994). Identifying the residential location of rapists. *Journal of the Forensic Science Society*, 34, 169-175.
- Canter, D. & Heritage, R. (1990). A multivariate model of sexual offence behaviour: Developments in 'offender profiling' I. *The Journal of Forensic Psychiatry*, 1, 185-212.
- Canter, D. & Larkin, P. (1993). The Environmental range of serial rapists. *Journal of Environmental Psychology*, 13, 63-69.
- Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20, 37-46.
- Cornish, D.B. & Clarke, R.V.G. (eds) (1986). *The reasoning criminal: Rational choice perspectives on offending*. New York: Springer Verlag.
- Douglas, J. E., Burgess, A. W., Burgess, A. G., & Ressler, R. K. (1992). *Crime classification manual*. New York, NY, US: Lexington Books/Macmillan, Inc.
- Farrington, D.P. (1989). Self-reported and official offending from adolescence to adulthood. In M.W. Klein (ed.) *Cross-national research in self-reported crime and delinquency* (pp 399-423). Dordrecht, Netherlands: Kluwer.
- Fritzon, K. (2001) An examination of the relationship between distance travelled and motivational aspects of arson. *Journal of Environmental Psychology*, 21, 45-60.
- Fritzon, K., Canter, D. & Wilton, Z. (2001) The application of an action systems model to destructive behaviour: The examples of Arson and Terrorism. *Behavioral Sciences and the Law*, 19, 657-690
- Harman, H.H. (1976). *Modern factor analysis*. Chicago, Illinois: The University of Chicago Press.
- Holsti, O. R. (1969). *Content analysis for the social sciences and humanities*. Reading, Massachusetts: Addison-Wesley Publishing Company.
- Häkkinen H., Puolakka P., & Santtila P.(in press). Crime scene actions and offender characteristics in arson.
- Home Office (1999) Safer Communities: Towards effective arson control. The Report of the Arson Scoping Study.
- Jackson, H.F. (1994) Assessment of Firesetters. In M. McMurran and J.Hodge (eds) *Assessment of criminal behaviours of clients in secure settings*. pp. 94-126. Jessica Kingsley: London.
- Jackson, H.F., Glass, C. & Hope, S. (1987). A functional analysis of recidivistic arson. *British Journal of Clinical Psychology*, 26, 175-185.
- Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*. Beverly Hills, CA: Sage.
- MacCulloch, M.J., Snowden, P.R., Wood, P.J.W. & Mills, H.E. (1983). Sadistic fantasy, sadistic behaviour and offending. *British Journal of Psychiatry*, 143, 20-29.
- McClelland, D.C. (1980). Is Personality Consistent? In A.I. Rabin, J. Arnoff, A.M Barclay

- and R.A. Zucker (Eds.) *Further explorations in personality*. New York: Wiley.
- Miller, S. and Fritzon, K. Functional consistency across two behavioural modalities: Firesetting and self harm in female special hospital patients. Submitted to *Criminal Behaviour and Mental Health*
- Pervin, L.A. (1989). *Personality Theory and research*. J. Wiley & Sons.
- Pulkkinen, L.(1983). The search for alternatives to aggression. In A.P. Goldstein and M.H. Segal (eds) *Aggression in Global perspectives* (pp. 104-144). New York: Pergamon Press.
- Santtila, P., Häkkänen, H. & Fritzon, K. (2003) Inferring the characteristics of an arsonist from crime scene behaviour: a case study in offender profiling. *International Journal of Police Science and Management*, 5(1) 1-15. .
- Sapp, A.D., Huff, T.G., Gary, G.P., Icové, D.J. & Horbert, P. (1994). A report of essential findings from a study of serial arsonists. Quantico, Virginia: National Centre for the Analysis of Violent Crime, FBI Academy.
- Shye, S. 1985. Nonmetric multivariate models for behavioral action systems. In D.Canter (Ed.) *Facet theory Approaches to social research* pp. 97-148). New York: Springer Verlag.
- Shye, S., Elizur, D., & Hoffman, M. (1994). *Introduction to facet theory: Content design and intrinsic data analysis in behavioural research*. London: Sage Publications.
- Tabachnick, B.G. & Fidell, L.S. (2001). *Using multivariate statistics*. New York: Allyn and Bacon.
- Authors' Note:** All correspondence should be addressed to Dr. Pekka Santtila, Police College of Finland, P.O. Box 13, 02151 Espoo, Finland. E-mail: pekka.santtila@pakk.poliisi.fi
- This research was financially supported by the Finnish Ministry of Interior and by Grant 54456 from the Academy of Finland.